How can Australian agriculture help us avoid our own Insect Apocalypse?

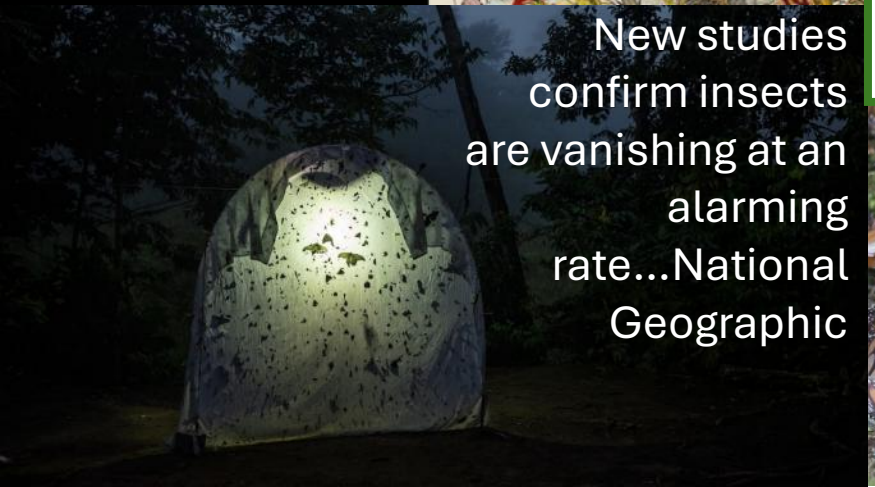
Dr Anthony Rice, Granite Belt IPM

GRANITE BELT
Integrated Pest Management

Lower Blackwood Catchment
Land Conservation District Committee

The Scary Reality of a Global Insect Apocalypse: foodrevolution.org

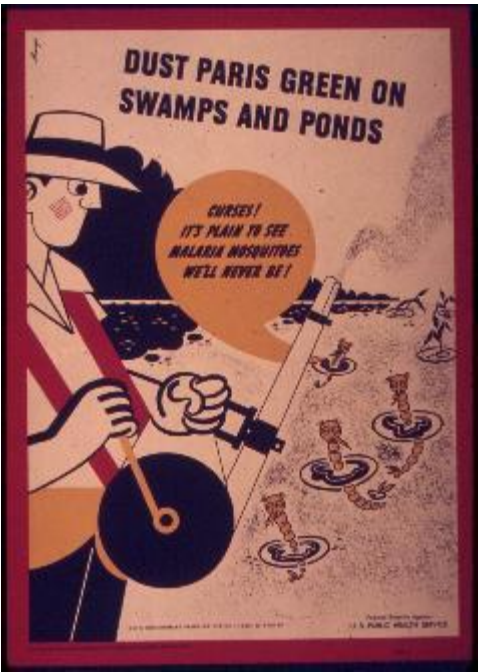
- Why do we need to change?
- What is IPM?
- ‘pIPMing’ your patch using beneficials that you already have.
- Case study: IPM Red Legged Earth Mite



Brief History of IPM

Fun fact: 1880's Paris green (arsenic) became the first widely used chemical pesticide in the world. Used on potatoes for beetles and tobacco for caterpillars

- Prior to WWII sulphur, neem, some heavy metals among others were used in pest management
- Research into nerve gasses led to discovery of the insecticidal properties of organochlorines, carbamates and organophosphates including DDT
- Very effective

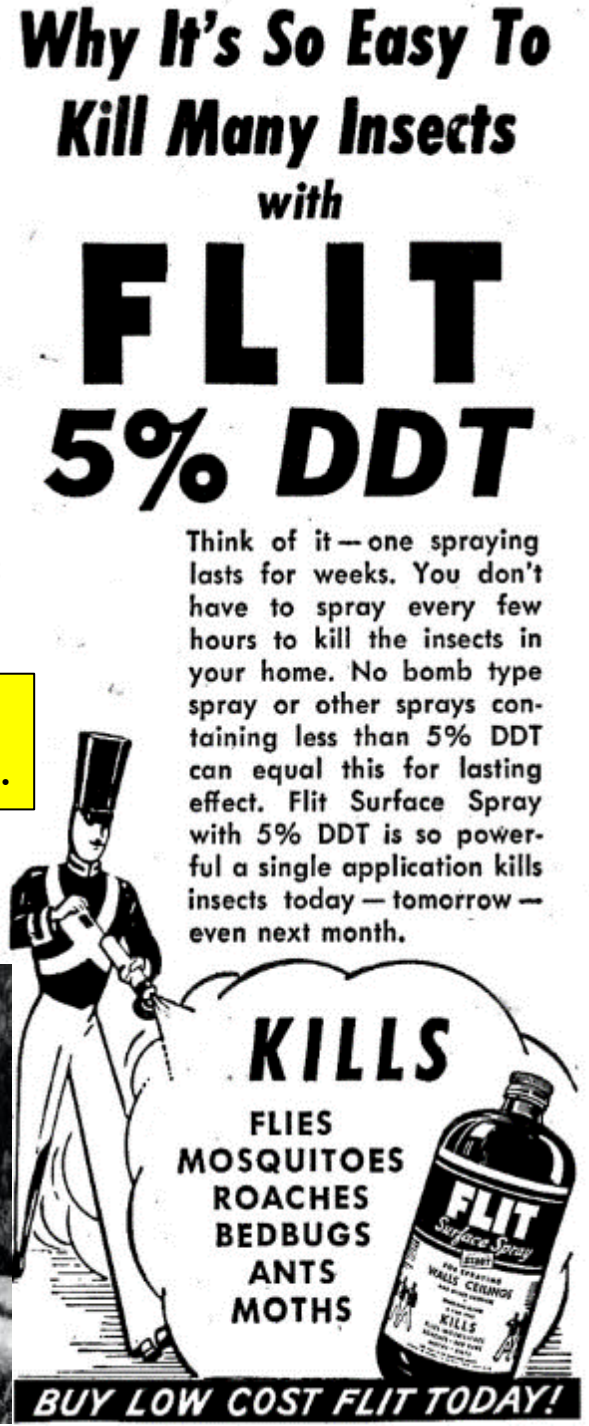


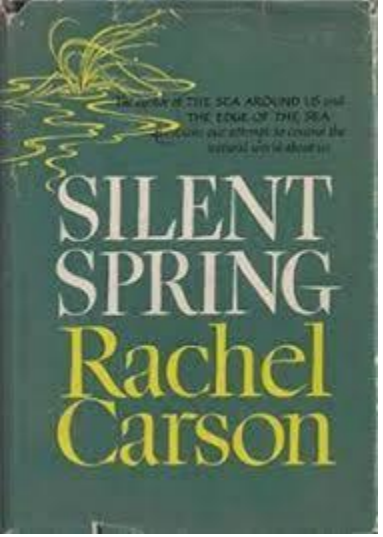
Fun fact: Sarin gas is an organophosphate (OP). There are 39 OP's registered for use in Australian ag.

Increased reliance

Chemical Crisis: Increasingly more chemical required to do the same job due to resistance

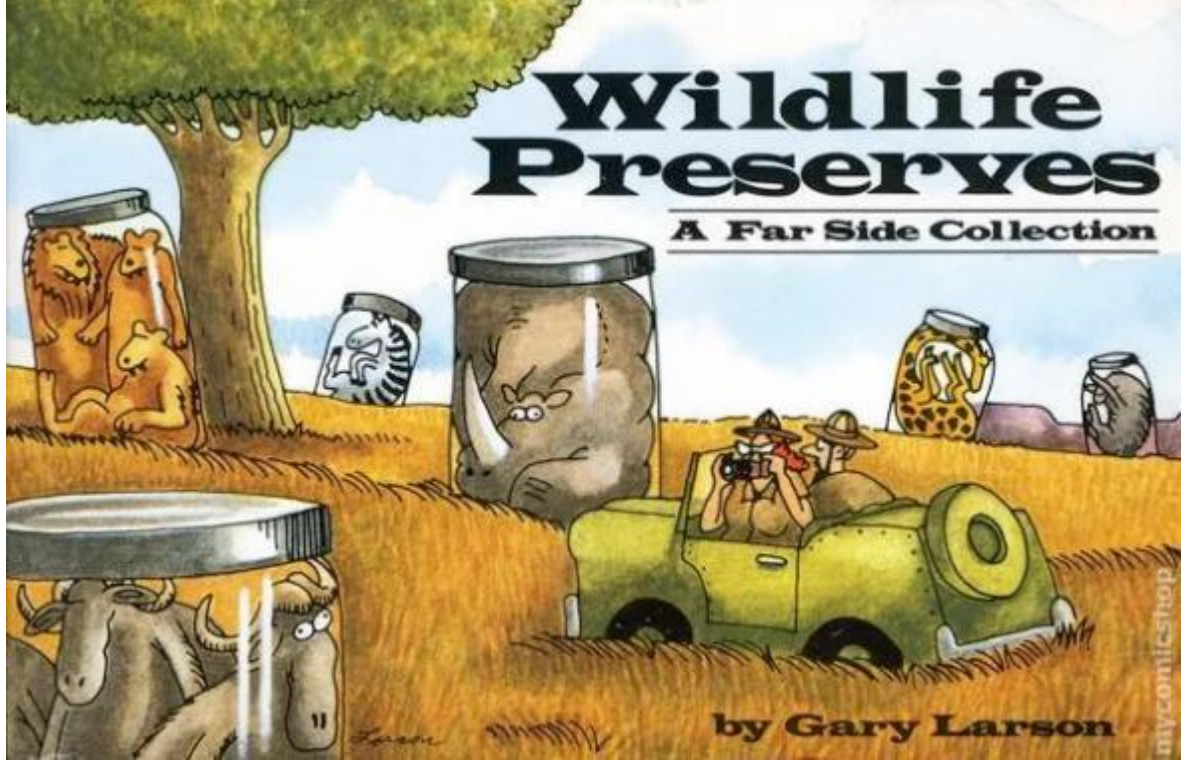
Aerial Spraying DDT





1962

- Documented the environmental harm caused by indiscriminate pesticide use
- Beginning of mainstream environmental awareness



'Integrated Pest Management' popularised in early 1970's

- Concerted effort to bring it into mainstream production systems
- Endeavoured to
  - Make agroecosystems sustainable
  - Reduce synthetic pesticide use

Fun fact: Monsanto published Silent Spring rebuttal "The Desolate Year" October 1962 Monsanto Magazine pp4-9

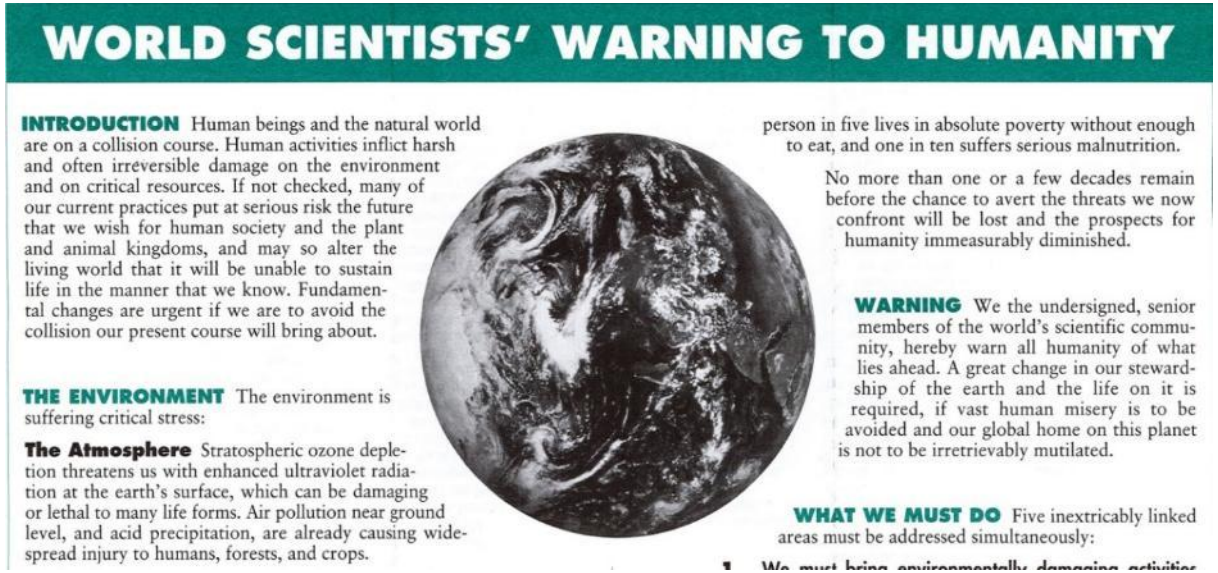
Yet six decades since Silent Spring "…. in the majority of cases, chemical control still remains the basis of plant health programs"

Deguine *et.al.* 2021

1992

The Alliance of World Scientists release their manifesto:

“World Scientists’ Warning to Humanity”



WORLD SCIENTISTS’ WARNING TO HUMANITY

INTRODUCTION Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about.

THE ENVIRONMENT The environment is suffering critical stress:

The Atmosphere Stratospheric ozone depletion threatens us with enhanced ultraviolet radiation at the earth’s surface, which can be damaging or lethal to many life forms. Air pollution near ground level, and acid precipitation, are already causing widespread injury to humans, forests, and crops.

person in five lives in absolute poverty without enough to eat, and one in ten suffers serious malnutrition.

No more than one or a few decades remain before the chance to avert the threats we now confront will be lost and the prospects for humanity immeasurably diminished.

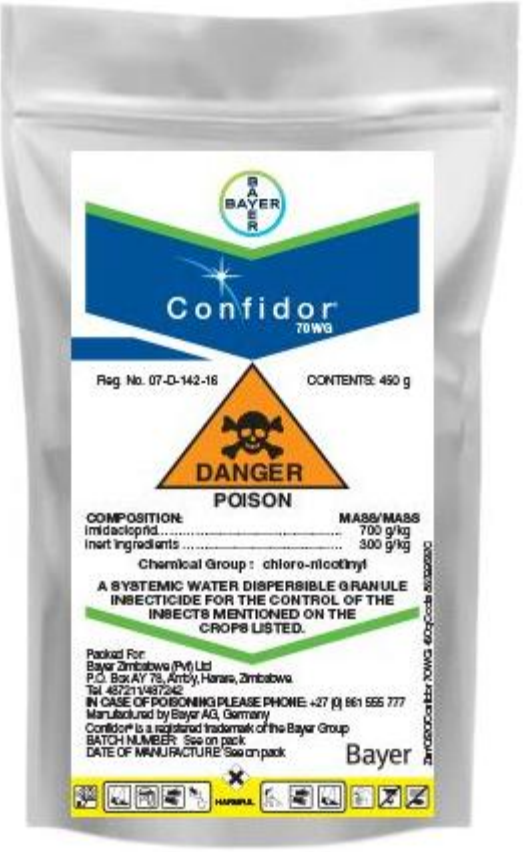
WARNING We the undersigned, senior members of the world’s scientific community, hereby warn all humanity of what lies ahead. A great change in our stewardship of the earth and the life on it is required, if vast human misery is to be avoided and our global home on this planet is not to be irretrievably mutilated.

WHAT WE MUST DO Five inextricably linked areas must be addressed simultaneously:

1. We must bring environmentally damaging activities

+

First product from a new group of insecticides called Neonicotines arrived in Australia – **Imidacloprid**



Neonicotines:

- Persistent
- Water soluble
- Systemic
- Effective at *extremely* low levels

2020

Scientist release a follow-up manifesto:

“Scientists’ Warning to Humanity on Insect Extinctions”

Biological Conservation 242 (2020) 108426

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

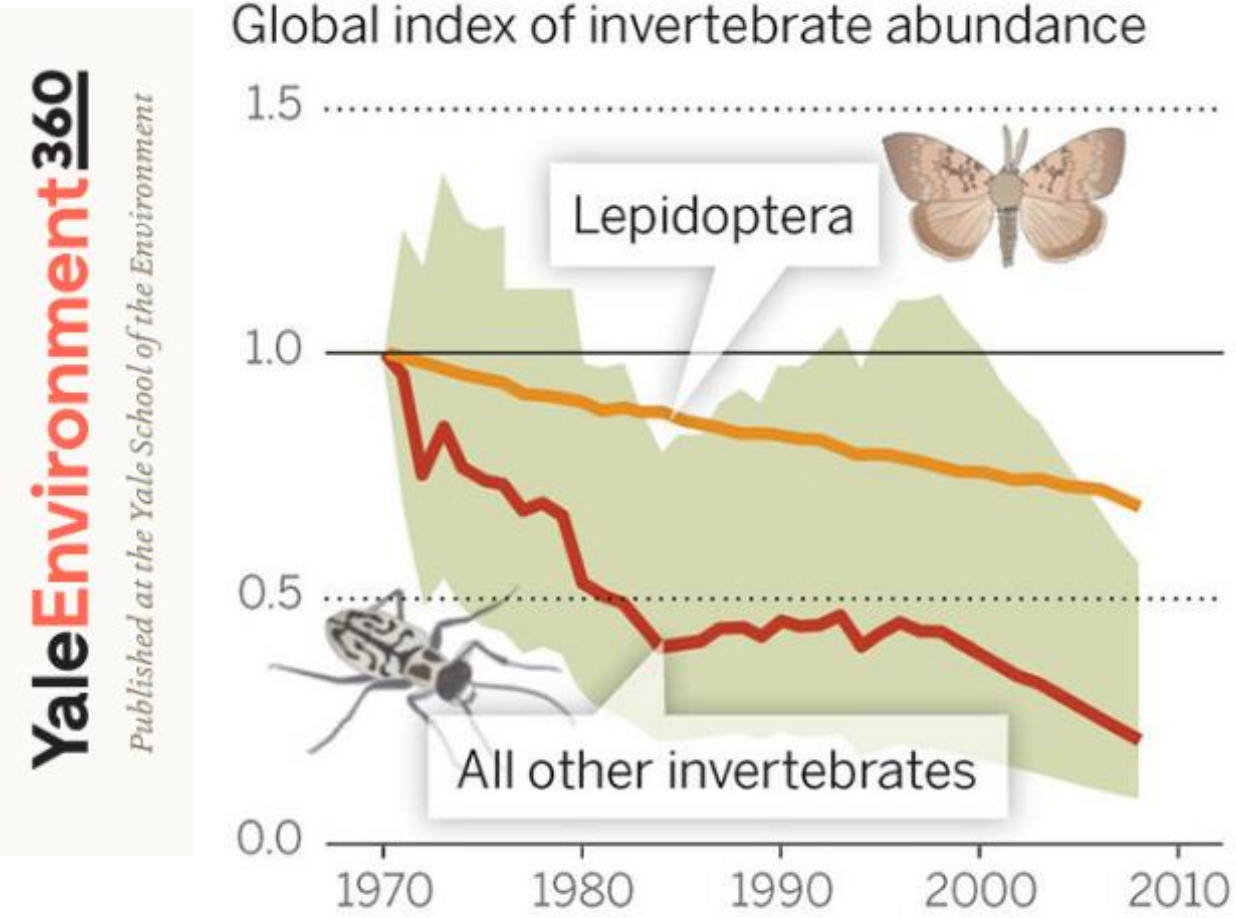
Perspective

Scientists' warning to humanity on insect extinctions

Pedro Cardoso[a,*], Philip S. Barton[b], Klaus Birkhofer[c], Filipe Chichorro[a], Charl Deacon[d], Thomas Fartmann[e], Caroline S. Fukushima[a], René Gaigher[d], Jan C. Habel[f], Caspar A. Hallmann[g], Matthew J. Hill[h], Axel Hochkirch[i,j], Mackenzie L. Kwak[k], Stefano Mammola[a,l], Jorge Ari Noriega[m], Alexander B. Orfinger[n,o], Fernando Pedraza[p], James S. Pryke[d], Fabio O. Roque[q,r], Josef Settele[s,t,u], John P. Simaika[v,w], Nigel E. Stork[x], Frank Suhling[y], Carlien Vorster[d], Michael J. Samways[d]

Image courtesy Minibeast Wildlife

The Insect Apocalypse

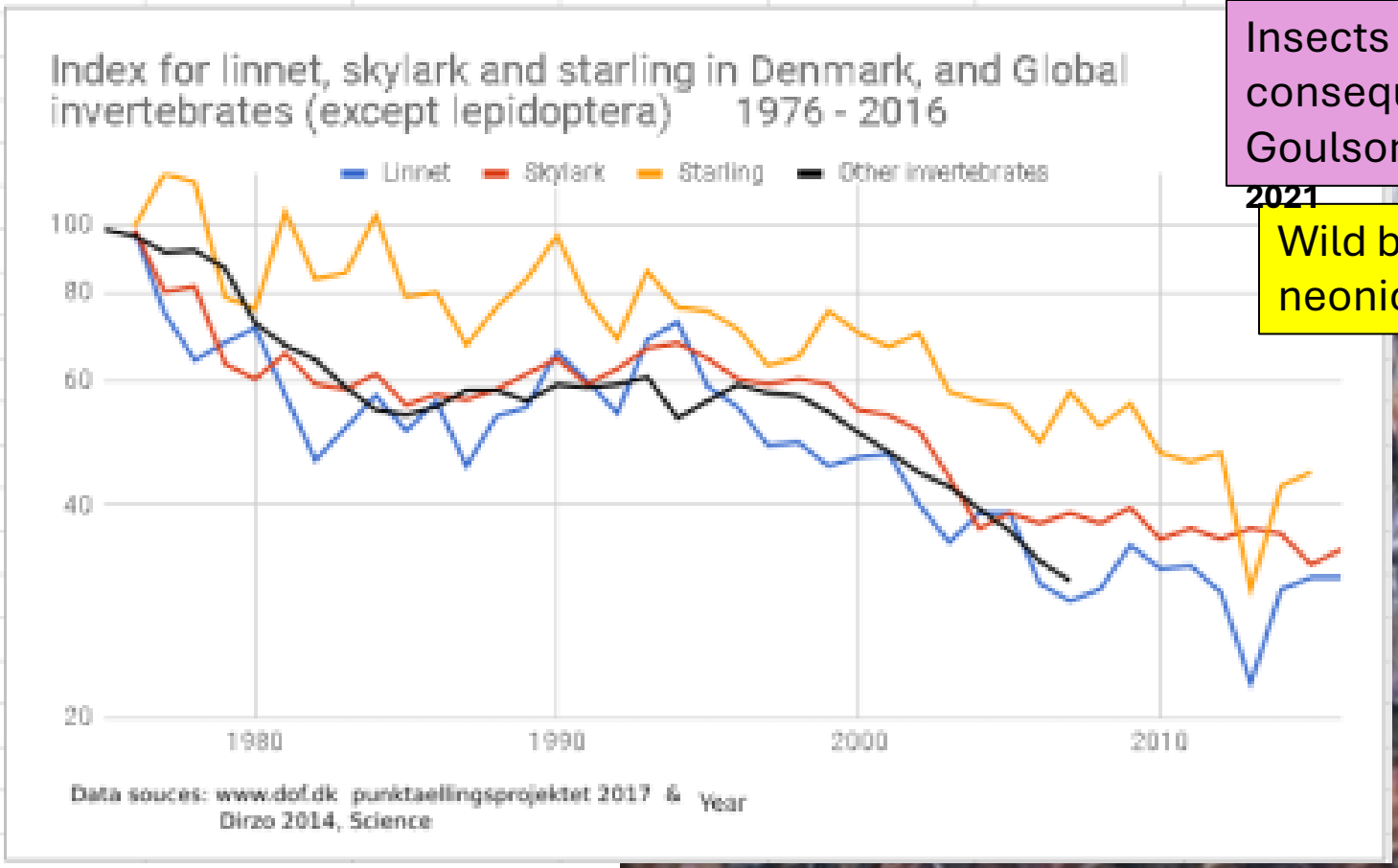


According to global monitoring data for 452 species, there has been a **45 percent** decline in invertebrate populations over the past 40 years. Dirzo, *Science* (2014)

Insect decline: an ecological Armageddon

Neonicotinoids like Imidacloprid have been described as a worldwide threat to biodiversity – but some EU countries (and Au) continue to use and/or export them. (**Pesticide Atlas** 2022)

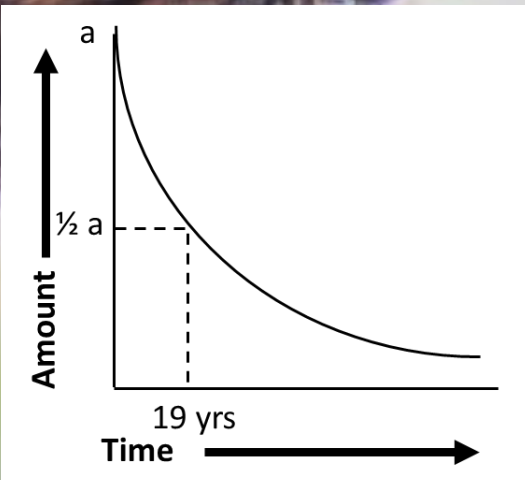
Insects have declined by 75% in the past 50 years – and the consequences may soon be catastrophic. Biologist Dave Goulson reveals the vital services they perform. **The Guardian 2021**



Wild bee declines have been ascribed in part, to neonicotinoid insecticides **Woodcock *et.al.* 2016 Nature Comms Vol. 7**

Fun fact: Clothianidin half-life in soils can be up to 19 years (U.S.EPA, 2010), and is often found in ground water, surface water and tap water (Van Dijk *et. al.*, 2013).

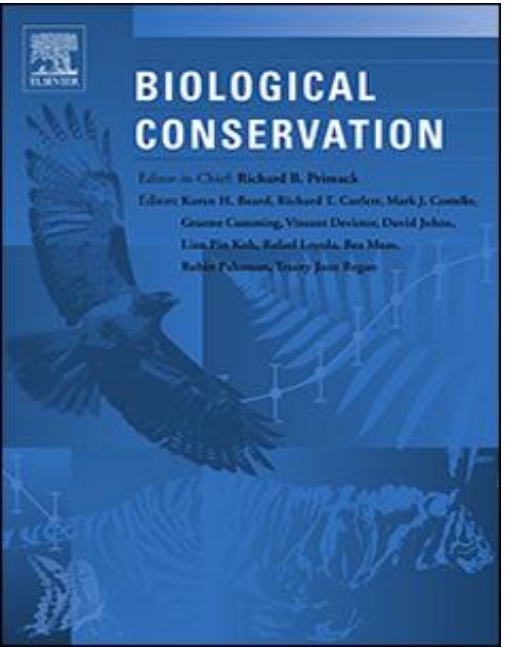
Use of neonicotinoids is restricted in EU but in 35% of countries have no pesticide legislation, ….the neonicotinoids are still the most commonly used insecticide in the world (Rowe, 2019).

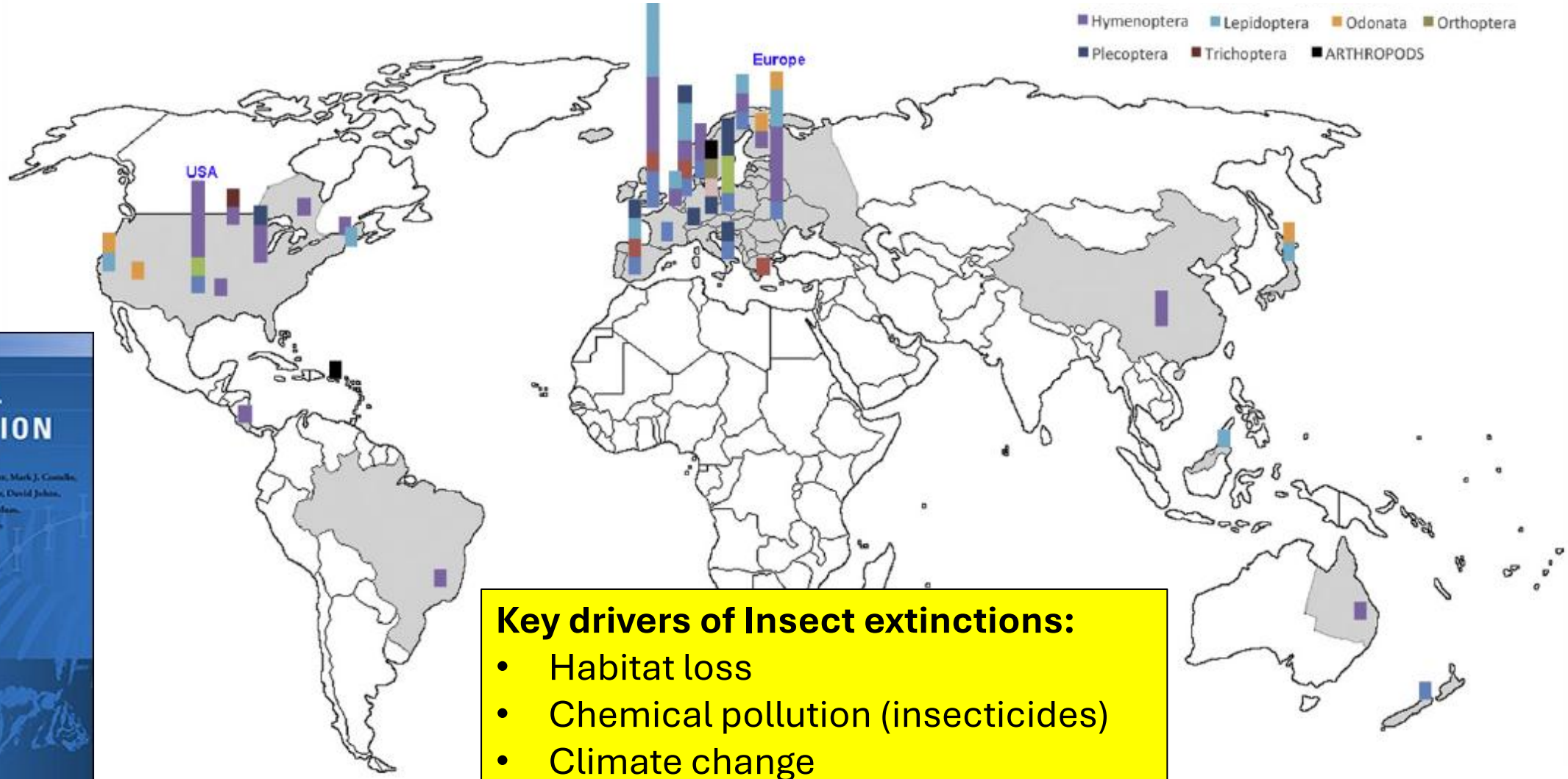


“Worldwide decline of the entomofauna: A review of its drivers”

F. Sanchez-Bayo, K.A.G. Wyckhuys

Biological Conservation 232 (2019) 8–27





Key drivers of Insect extinctions:

- Habitat loss
- Chemical pollution (insecticides)
- Climate change

Organophosphates to Neonicotines: out of the frying pan and into the pyre?

2025

Europe

- Three banned for field use in Europe since 2018
- Manufactured and exported

USA

- Implicated in Colony Collapse Disorder
- 86% of honey contaminated with at least one

Australia

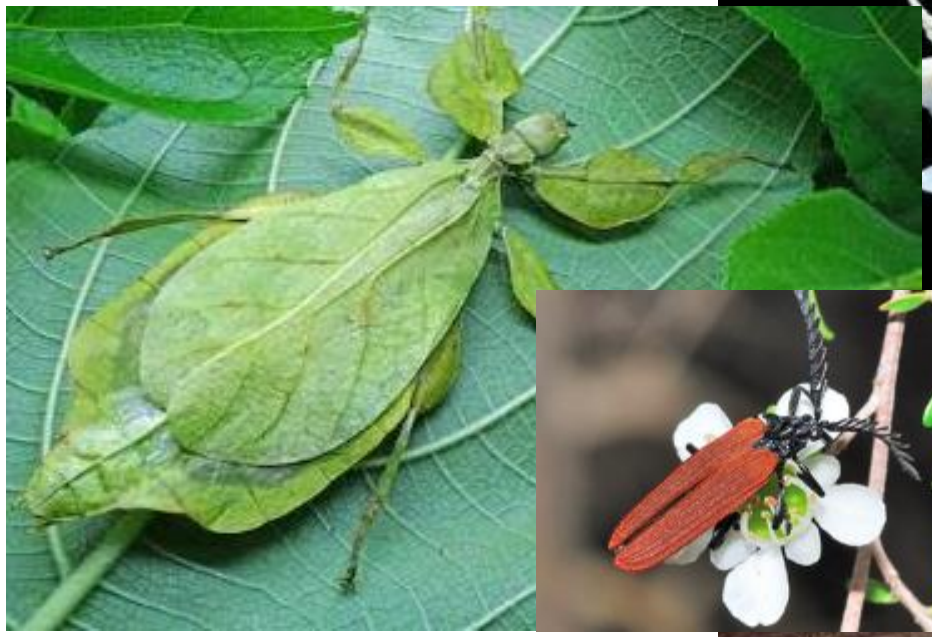
- Six neonicotines now registered for use in Australia
- APVMA – Reviewing regulatory decisions on neonicotines

"The current assumption underlying pesticide regulation – that chemicals that pass a battery of tests in the laboratory or in field trials are environmentally benign when they are used at industrial scales – is false," **Prof Ian Boyd, chief scientific adviser Department of Environment, Food and Rural Affairs. UK,**

Vertebrates – 60 000
Invertebrates - 30 000 000

Photograph by Nabokov, en.wikipedia.org.

- Class Insecta out-numbers all other animals o
  earth
- One to five million
  species
- Key roles:
  - Nutrient cycling
  - Pest control
  - Pollination
  - Decomposition
  - Main diet for numerous birds, bats and fish



Spiny flower mantis (South Africa)

Ecosystem Services

Animal Group	Estimated number of species - Global	Estimate % of species that rely on insects
Birds	10 000	97
Reptiles	7 000	>90
Mammals	6 640	100% (directly or indirectly)
Fish	15 000 (freshwater)	>90
Amphibians	8 000	>90

Without insects, the worlds ecosystems will collapse, and our food web will no longer support us

“Neonicotines may be the single greatest threat to our landscape functionality we have ever faced”

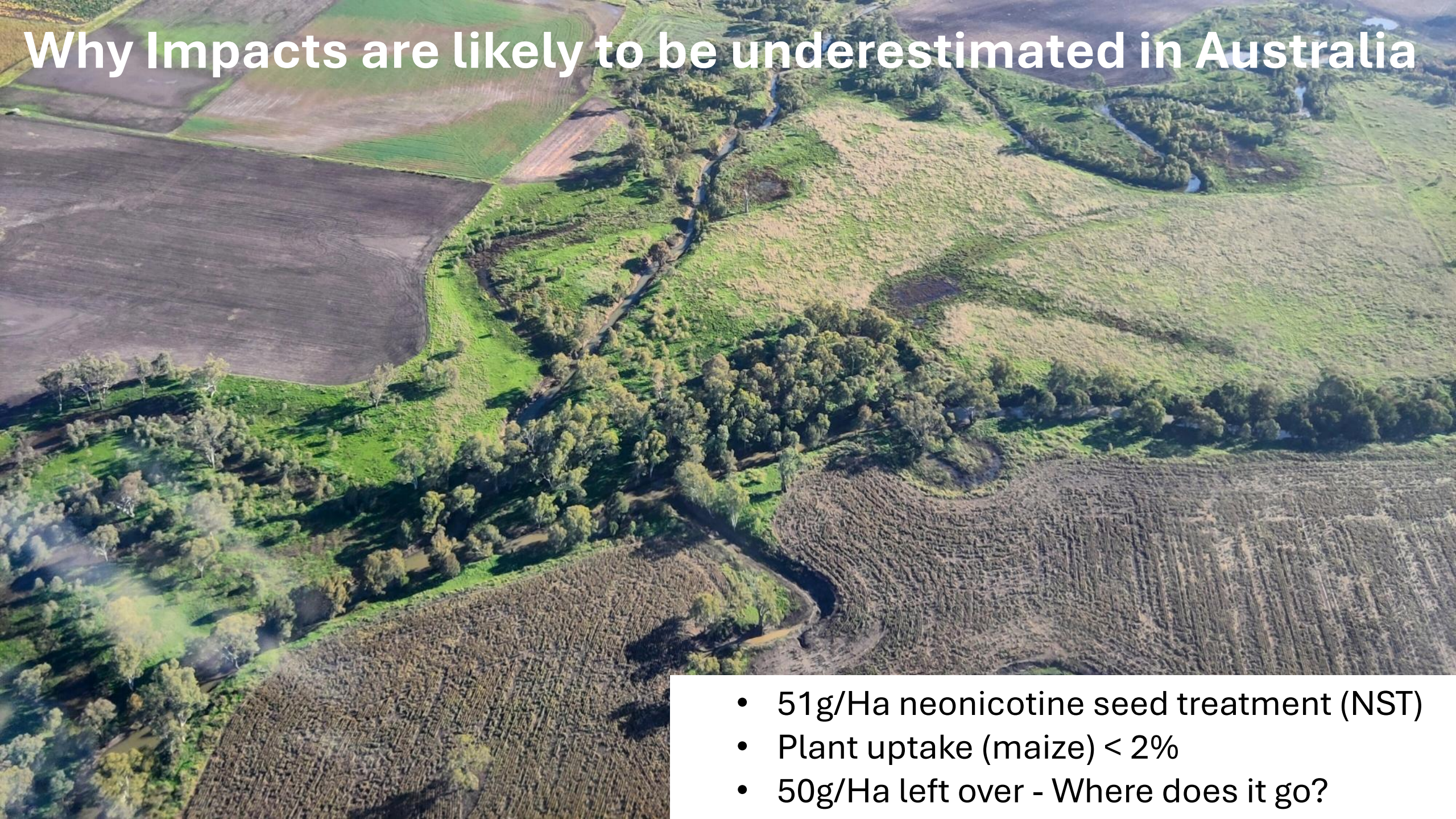
Why?

- LD50 bees 5 ng but if you wait longer, it can be as low as 0.004ng (4pg)
- At these rates, OECD protocols and commercial testing no longer up to the task.
- In sunlight, Imidacloprid and Clothianidin ½ life = days/weeks
- Used in seed treatments, ½ life = years (up to 19yrs – EPA).

- APVMA: 2023/2024 Australia purchased 67,104 kg of Imidacloprid
- $1.3x10^{16}$ (13 420 800 000 000 000) LD50 doses
- Dry mass of bees = 30 mg (0.03g) Honey Bee Equiv's (HBE)
- Global dry mass terrestrial arthropods 300mt = $1.0\ x10^{16}$ (10 000 000 000 000 000) HBE's

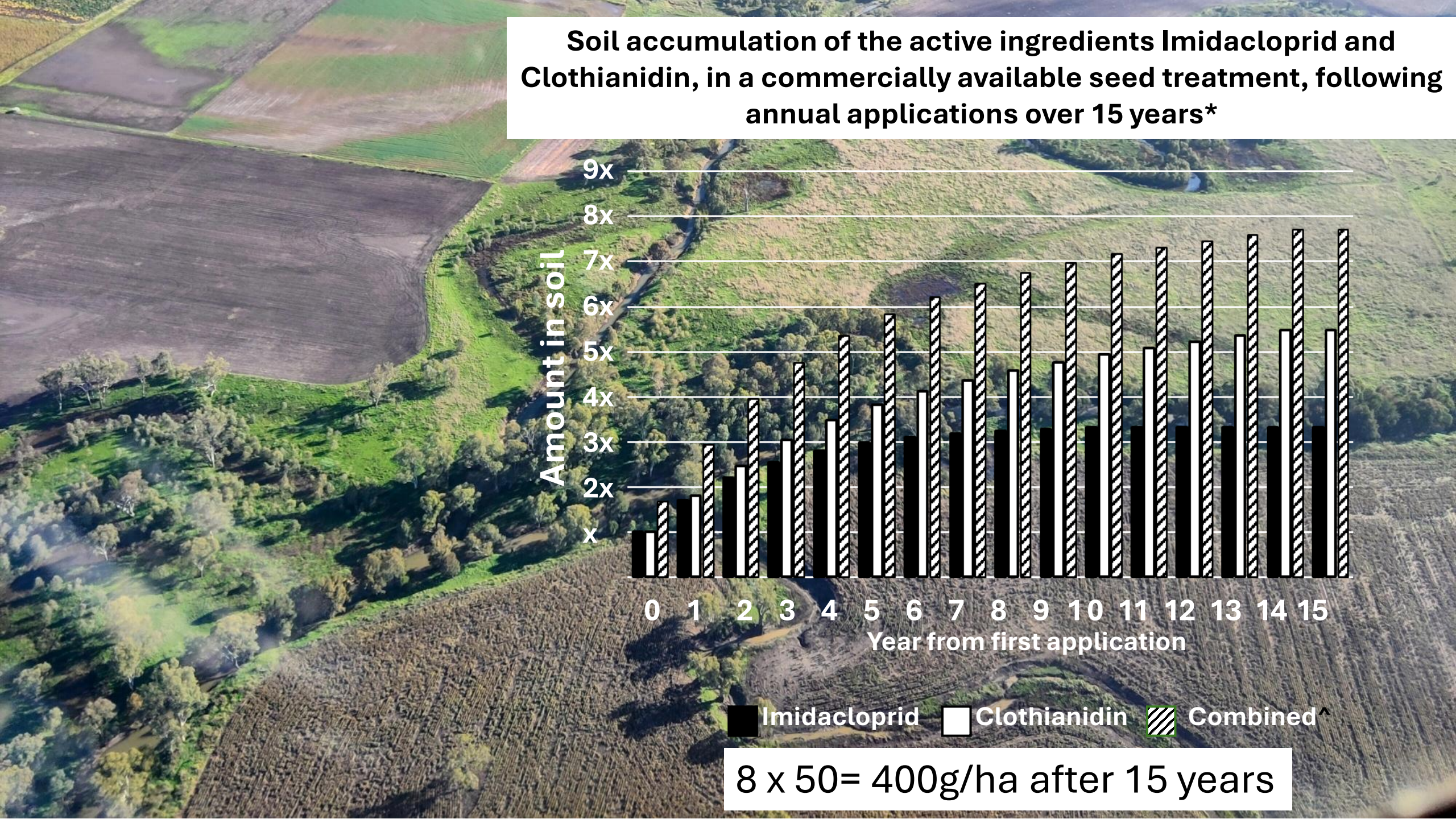
Therefor in 2023/24, Australia used enough Imidacloprid to kill every terrestrial Arthropod on the planet.

Why Impacts are likely to be underestimated in Australia



- 51g/Ha neonicotine seed treatment (NST)
- Plant uptake (maize) < 2%
- 50g/Ha left over - Where does it go?

Soil accumulation of the active ingredients Imidacloprid and Clothianidin, in a commercially available seed treatment, following annual applications over 15 years*



8 x 50= 400g/ha after 15 years

BUT we don’t need them

- France – 97% of cases NST not useful
- Canada – 95% of cases NST not useful
- US – “Negligible benefits” in soybeans
- 1990’s about 50% of corn was treated with an insecticide by 2011, nearly 100% was treated with NST

Addiction: “an inability to stop doing or using something harmful”

What is IPM and how can it help?

What is Integrated Pest Management?

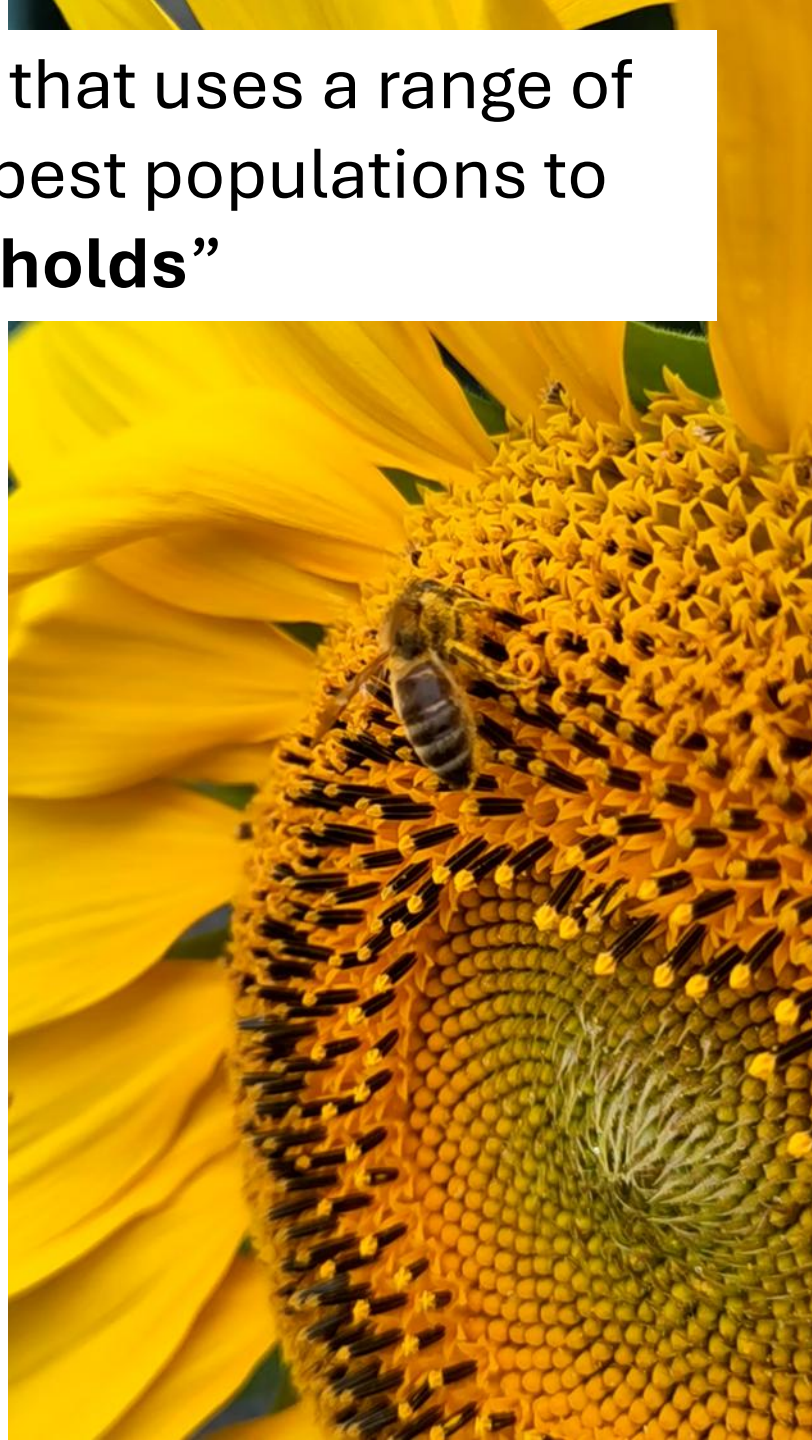
"Management practice that uses a range of techniques to supress pest populations to below **economic thresholds**"

Cermatulus nasalis feeding on white cabbage butterfly larvae

- Should be based on comprehensive population data on pest and beneficials
- Allow for sub-economic pest levels

IPM

1. Cultural techniques
2. Biological control
3. Biorational pesticides
4. Chemical control
   - Narrow spectrum
   - Broad spectrum



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Eight First Steps

IPM

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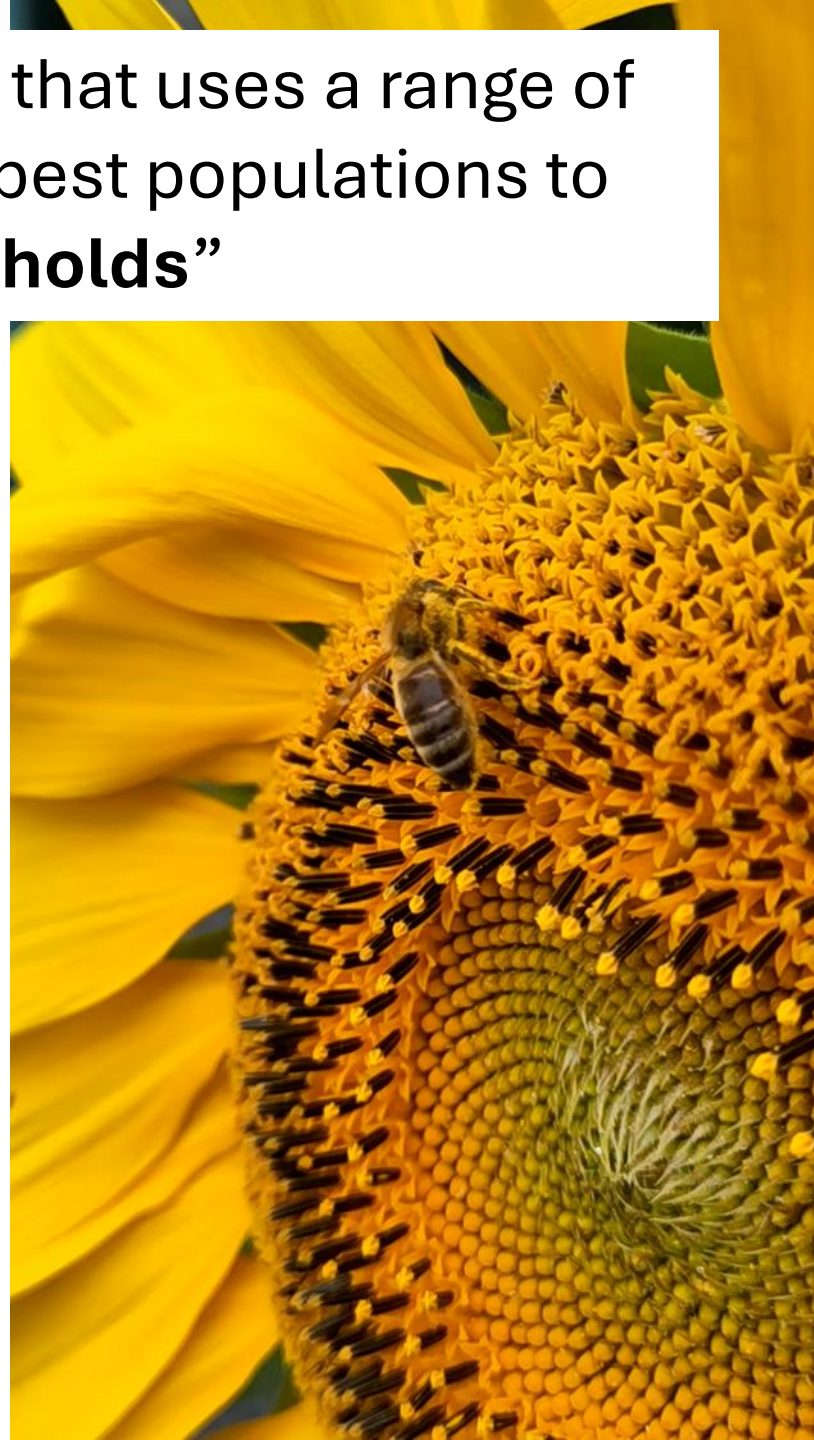
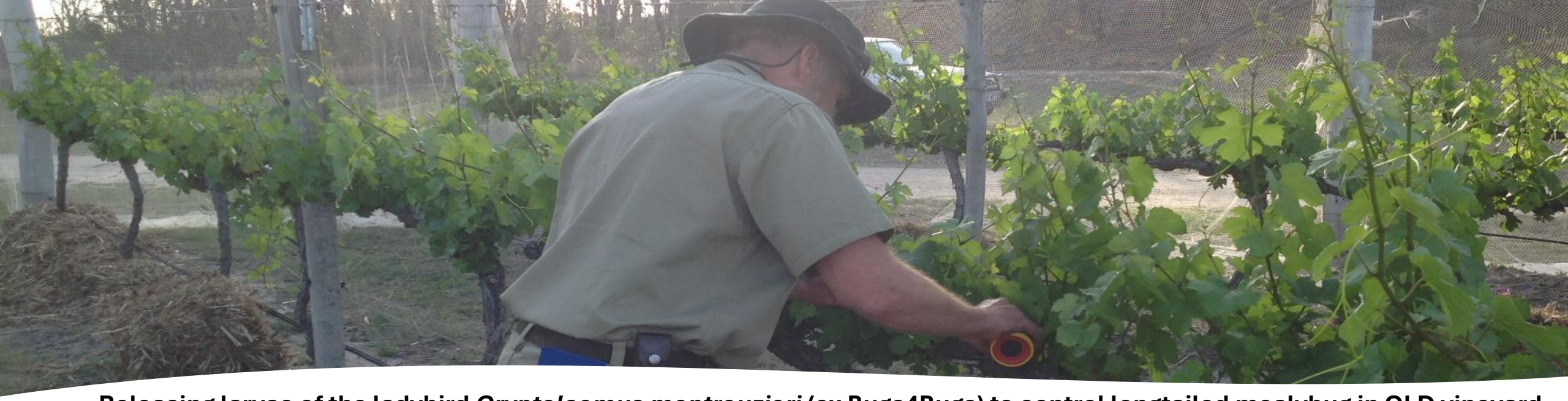
4. Chemical control
   - Narrow spectrum
   - Broad spectrum





Releasing larvae of the ladybird *Cryptolaemus montrouzieri* (ex Bugs4Bugs) to control longtailed mealybug in QLD vineyard

- IPM does not specifically aim to reduce insecticide use, its main goal should be productivity and sustainability.
- Unless it's seen as a good business decision, uptake will be slow but demonstrating its economic viability is difficult and may require several seasons
- However, its likely to see increased adoption because:
  - Overuse-induced resistance eg Indoxacarb
  - Public pressure

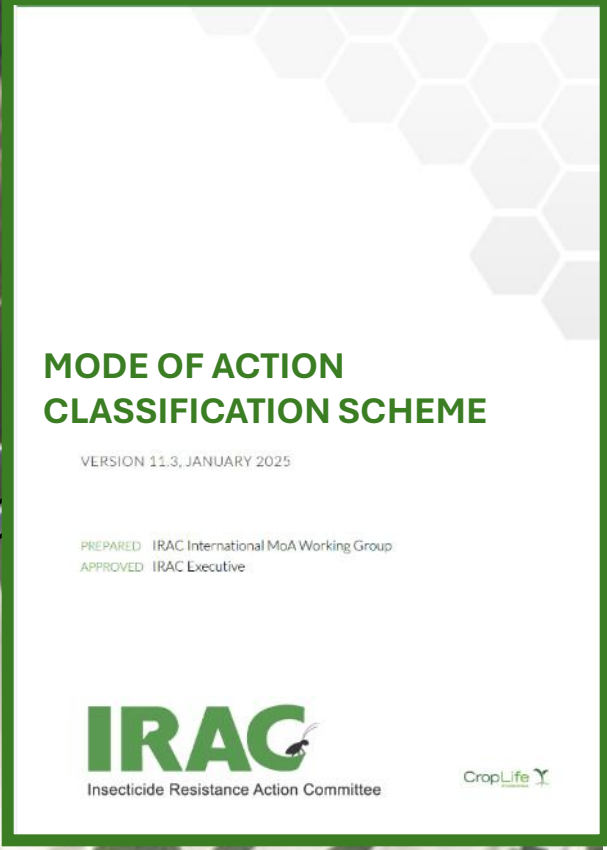
Step 1. Stop using Neonicotine seed treatments

Incompatible with IPM because:

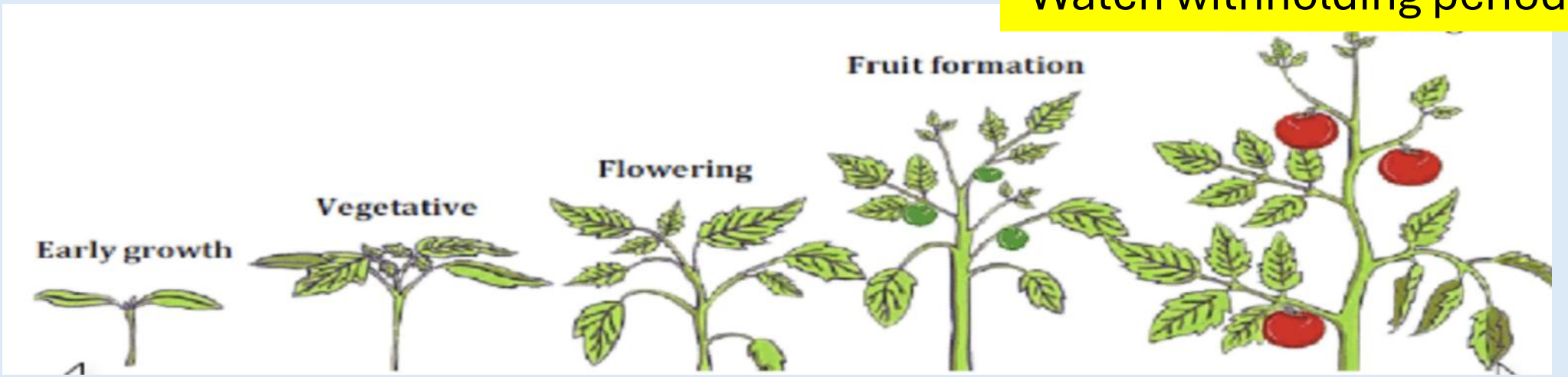
- Seed treatments are universally used for a pest problem that doesn’t exist
- Science tells us that we don’t need them (France, Canada, US)
- There is no data to say what happens to Natural Enemies when they feed on treated pests
- Killing all of your pests so early in the crop cycle means you have nothing to attract and sustain natural enemies

Step 2. Rearrange insecticides in the chemical shed – MoA#

- *Insecticide Resistance Action Committee (IRAC) Mode-of-Action Table*
- Broadly, the higher the number, the newer the chemical



Watch withholding periods!!



MoA Group ....36,35,34,33,32,31,30,29,28,25A, 25B,..... 2B,2A,1B,1A

Highest → Lowest

Effects of pesticides on beneficials

Horticulture Innovation Australia Limited

Cucurbits and Fruiting vegetables

A guide to pesticide effects on beneficials

2020

Two great reference documents

CRDC - Cotton Pest Management Guide 2024-2025

Pages 20-21

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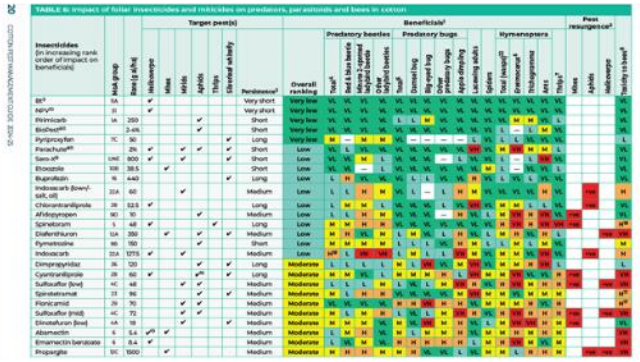


Step 3. Talk to your pest scout

Why Pest Scouts are fundamental to change

- What is a pest scout/crop checker?
- Why do you probably need one?
- What can they do for you on your IPM journey

As DPI extension officers became scarce two main types of pest scouts replaced them: one paid by selling chemicals and one who gets paid by helping you spraying less.

Starting the conversation – “Can you help me?”

What sort of data do you need to make IPM decisions

Tomatoes																							
		Mites			Insect Pests											Beneficials							
DNC = Did Not Check **?** = maybe dead D = =damage	Number of sites	Rust Mites	Broad mites	2-spotted mites	Thrips in flowers	Helicoverpa eggs	Helicoverpa larvae sm	Helicoverpa larvae lg	Fruit fly	Aphids	Leafhoppers	Rutherglen bug	Green Vege Bug	Hoverfly	Pred Mites	Predatory thrips	Spiders	Stethorus	Cryptolaemus	Predatory beetles	Orius	Ladybird beetles
Block B																						
3/02/2025	**12**				14		2															
11/02/2025	**12**				48																	
16/02/2025	**12**				32																	
22/02/2025	**12**				20												2					
27/02/2025	**12**				24																	
12/03/2025	**12**				4	4																
19/03/2025	**12**				24	6	2										4					
26/03/2025	**12**								Nil													
1/04/2025	**12**								Nil						8		4	6		8		4
8/04/2025	**12**										6									5		5
23/04/2025	**12**						2								8					10		4

Step 4. Work with pest thresholds

"A pest threshold is the level of pest pressure above which economic loss exceeds the cost of treatment"

Chemical labels (Imidacloprid): "spray at the first sign of" pest

However:

- In a system that is not dominated by chemical interventions, a few pests in your crop can be a good thing

Working out a thresholds to start with

Consider:

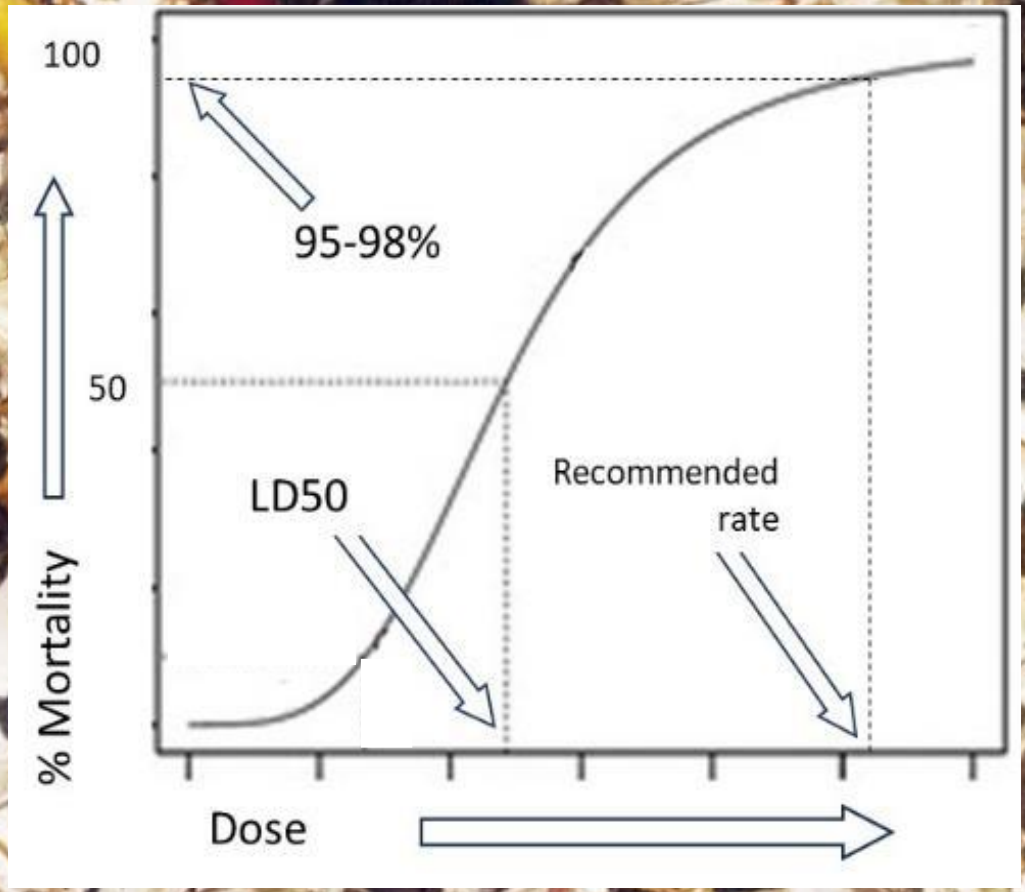
- Recent history
- Natural enemies present
- Get some preliminary data to compare with existing practices

Explainer: Recommended rate and LD50

Most recommended rates on insecticide labels will kill 95-98% of a pest population

"Some naturally occurring insect biotypes resistant to [product name] and other group x insecticides may exist through normal genetic variability in any insect population. The resistant individuals can eventually dominate the insect population if [product name] and other Group x insecticide are used repeatedly"

- 'Response curve' developed in the laboratory by chemical manufacturers
- LD50 = lethal dose for 50% of population)
- Recommended rate is a tradeoff between efficacy and practicality



Step 5. Coverage is King! (The 'C' word)

A 95-98% pest mortality relies on 100% coverage i.e. every pest individual gets a lethal dose.

Improving your coverage

- Pruning
- Planting
- Calibration
  - Use spray cards
  - Get professional help

Coverage %	Efficacy %
100	95-98
90	85.5 – 88.2
80	76 - 78.4
70	66.5 – 68.6
60	57 – 58.8

Step 6. Identify your top 3-4 pests.

IPM consultants: “correct ID is essential for ……IPM…”
Instead, most farmers can recognise their 3 or 4 top pests and plan a strategy for them
Eg capsicums and tomatoes in the Granite Belt QLD

Caterpillars

Thrips

Fruit fly

Mites

Step 7. Farm Biosecurity.

Prevent pests (and diseases) getting there in the first place, can be important for flightless pests like mites and garden weevil

- As a general rule work your youngest and or cleanest blocks first
- Note that air-blast sprayers are pest spreaders

Step 8. Acknowledge that in most cases, insecticides have no impact on prevalence of insect-vectored disease.

Hard sell – seems intuitive to spray them and this will help protect the crop

"Once you have symptoms, you are throwing money away on vector control"

- Regular hard insecticides didn't stop tomato big bud phytoplasma in toms in Granite Belt – whole block infected.

How can we help invertebrate biodiversity in the garden at home?

Insects are dying: here are 25 easy and effective ways you can help protect them

The Guardian Aus

From turning out the lights to letting leaves rot, these small steps can create big changes at home or in the wild

- 'Half the tree of life': ecologists' horror as nature reserves are emptied of insects

OPINION | ENVIRONMENTAL SCIENCES |

PNAS

Eight simple actions that individuals can take to save insects from global declines

Akito Y. Kawahara, Lawrence E. Reeves, Jesse R. Barber, and Scott H. Black Authors Info & Affiliations

January 11, 2021 | 118 (2) e2002547117 | https://doi.org/10.1073/pnas.2002547117

Eight steps for the home gardener to create an insect-friendly space

Beware potted plants may be treated with imidacloprid or other group 4A insecticides

1. Plant flowers
    - Native plants are best, wherever you are in the world
    - Most likely to have the best nutrition and phenology

2. Reduce light pollution
    - DarkSky International:
        - Use only as necessary
        - Directional
        - Low level
        - Controlled
        - Warm colour

3. Avoid insecticides – tread carefully:
See ‘pIPM’ your patch ‘Home Garden’
https://granitebeltipm.com.au/howToIPM-HomeGarden.html

4. Convert lawns into more natural habitat

5. Leave the leaves

6. Be wary of flea treatments on dogs

7. Take pride in your ‘unkempt’ garden

8. Cut your carbon footprint

PERSPECTIVE | ECOLOGY |

Insects and recent climate change

Christopher A. Halsch, Arthur M. Shapiro, James A. Fordyce, +3, and Matthew L. Forister Authors Info & Affiliations

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January 11, 2021 | 118 (2) e2002543117 | https://doi.org/10.1073/pnas.2002543117

PNAS

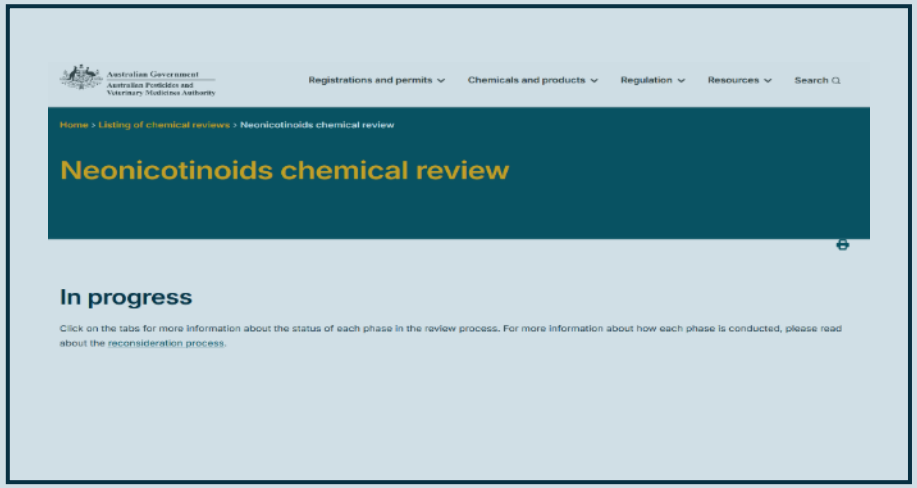
57,111 | 321

PDF/EPUB

Two more things.....

APVMA is reviewing the registration of Neonicotinoids in Australia. First decisions released late 2025

https://www.apvma.gov.au/chemicals-and-products/chemical-review/listing/neonicotinoids



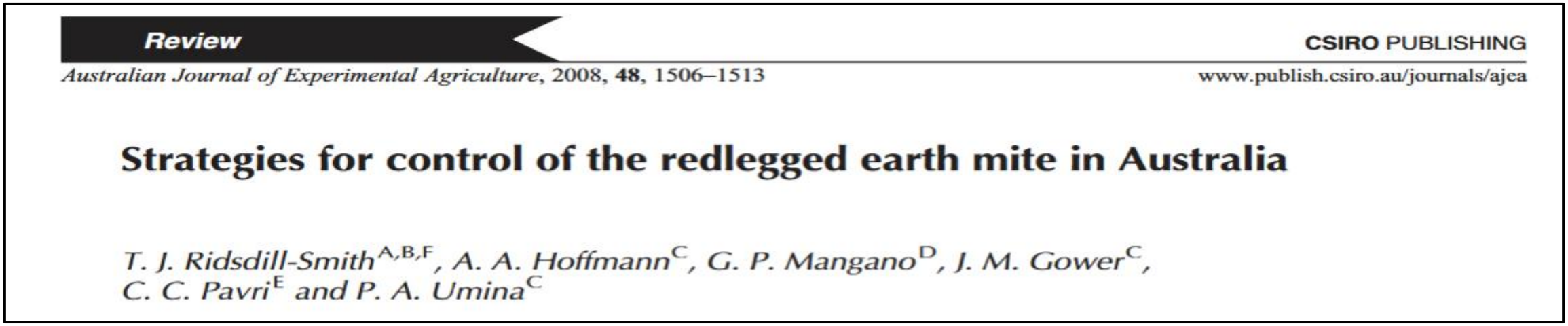
Buy imperfect fruit!

Case study: Integrated Pest Management of Red Legged Earth Mite (RLEM)

https://agriculture.vic.gov.au/biosecurity/pest-insects-and-mites/priority-pest-insects-and-mites/redlegged-earth-mite

https://cesaraustralia.com/pestnotes/mites/redlegged-earth-mite/

https://ipmguidelinesforgrains.com.au/important/uploads/GRDC_FS_RLEM_RMS_2018update_LR.pdf



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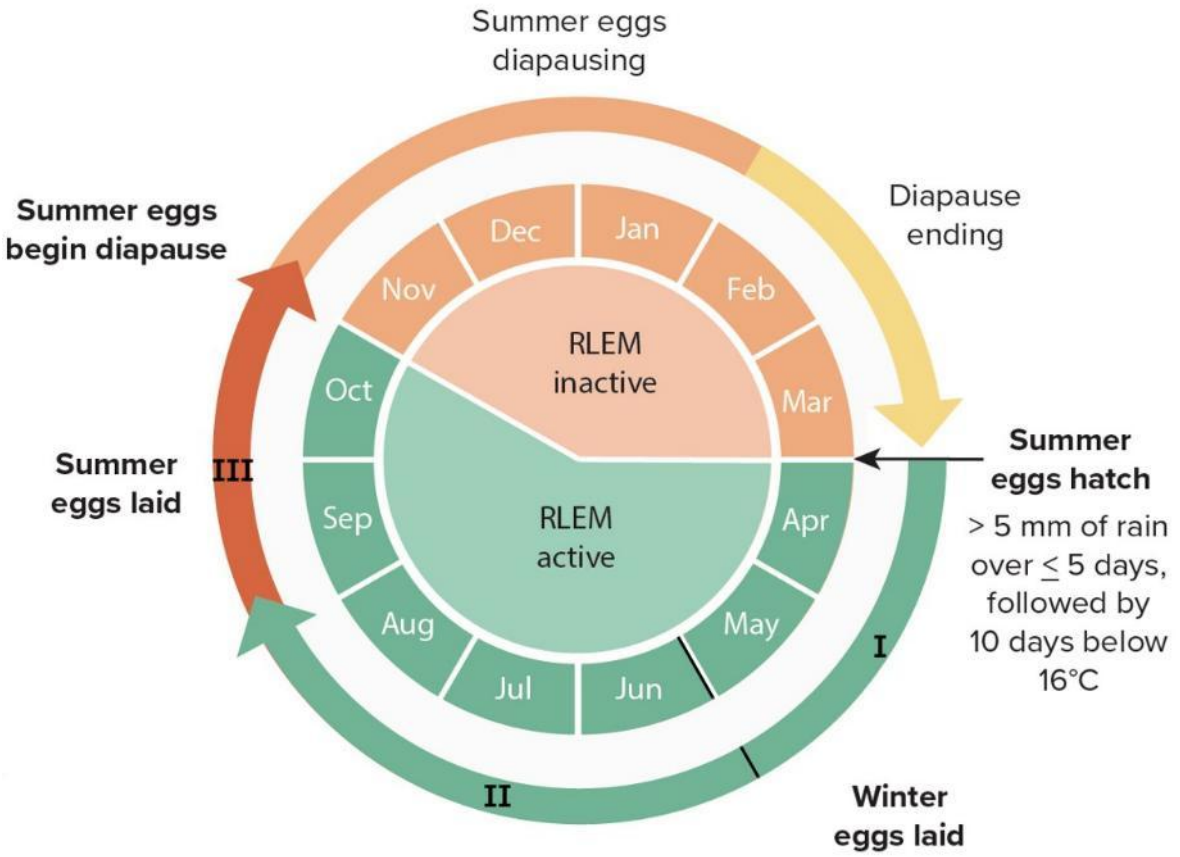

TIMERITE® was developed and funded by AWI and CSIRO. Updates and improvements were made by Cesar Australia and CSIRO, with funding from AWI, GRDC, MLA and Cesar Australia.

TIMERITE®

Your TIMERITE® Best spray date is 09/09/2025

Your TIMERITE® Ideal spray window is **22/08/2025** to **24/09/2025** for the postcode of 6258 PERUP.

Green line = Best spray date
Red line = User selected spray date (you can move this to different dates by clicking on the black dots in the graph below to see the effect on diapause and population recovery)
Grey box = Ideal spray window

Mite control efficacy (%)

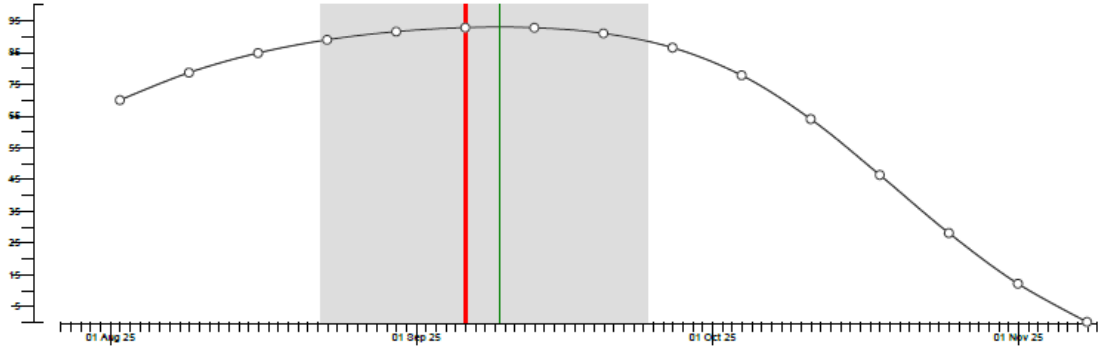

TABLE 1 IPM strategies for the redlegged earth mite.

Season	Management option	Comment
Previous year (winter/spring)	Keep pastures short in early spring	Ideally graze to <1.4t/ha food on offer 3-4 weeks prior to the Timerite® date[1]. Heavily grazed spring paddocks will not require an insecticide spray.
	Keep fencelines clean	Spray out broadleaf weeds (especially in capeweed) along fencelines of paddocks that contain RLEM.
	Use selective chemicals	Where possible avoid using organophosphates (OPs) or synthetic pyrethroids (SPs) for control of spring pests other than RLEM. For example, use pirimicarb for control of aphids and *Bt*, NPV, spinetoram or emamectin benzoate for control of caterpillars.
	Use mite-tolerant pasture species	For continuing pastures, consider selecting varieties with known mite tolerance. The pasture legume *Trifolium glanduliferum* (cv Prima gland clover) is less susceptible to RLEM feeding. Subterranean clovers – Narrikup$^{\phi}$, Bindoon$^{\phi}$ and Rosabrook$^{\phi}$ – may suffer less damage from RLEM than other varieties.
	Use mite-tolerant crops	In situations where significant resistance issues exist, consider selecting crop types that are less susceptible to RLEM. Cereals are more tolerant than canola, and are typically better at compensating for early RLEM feeding damage. Some pulse crops, such as lentils and chickpeas, are not favoured by RLEM.
Pre-sowing	Control weeds 2 weeks before sowing	Control all weeds (especially capeweed and Paterson's curse) using herbicides or cultivation within paddocks and along fencelines at least 2 weeks in advance of intended sowing date. This is especially important in 'late break' years where mites have hatched and are feeding on pre-sowing weeds.
	Avoid bare-earth sprays prior to mite hatch	Do not apply preventative insecticides against RLEM in seasons where crops are sown in advance of known mite-hatching events.
	Use higher seed rates	Consider higher seeding rates to allow for some mite feeding damage and plant loss (especially in canola).
Emergence and crop establishment	Monitor and use spray thresholds	Monitor susceptible crops through to establishment using direct visual searches, and use thresholds to inform spray decisions. Avoid preventative or prophylactic insurance sprays.
	Use barrier sprays if mites invade from edges	Be aware of edge effects; mites move in from weeds around paddock edges. Where RLEM are colonising crop margins and fencelines in the early stages of population development, consider a barrier spray with an insecticide to prevent/delay the build-up of RLEM and to retain beneficial species.

1 Timerite® is a carefully timed chemical application in spring. This approach can drastically reduce the number of 'over-summering' diapause eggs produced by RLEM. If applied correctly, Timerite® will decrease the density of mites that emerge the following autumn. Further information is available at: www.wool.com/timerite

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GRANITE BELT IPM GLOBAL

Reducing the environmental cost of farming with Integrated Pest Management

Lower Blackwood Catchment

Land Conservation District Committee